TABLE 25. RATIO OF RESEARCH AND DEVELOPMENT EXPENDITURES TO VALUE ADDED IN MANUFACTURING IN LEADING INDUSTRIAL COUNTRIES, SELECTED YEARS, 1963/1964 TO 1973 (In percent)

	Enterprise-Funded					Total				
	1963/1964	1967	1969	1971	1973	1963/1964	1967	1969	1971	1973
United States	2.7	2.7	3.2	3.3	3.1	6.3	5.8	5.9	5.6	5.0
Canada	1.1	1.4	1.3	1.2	1.2	1.3	1.7	1.6	1.5	1.6
France	1.4	NA	1.6	1.8	1.9	2.2	3.3	2.8	2.7	2.8
Germany	2.0	2.2	2.3	2.6	2.3	2.1	2.6	2.6	3.0	2.9
Italy	1.3	1.5	1.5	1.9	1.3	1.3	1.6	1.6	2.1	1.5
Japan	2.2	2.2	2.5	2.8	3.6	2.2	2.2	2.6	2.8	3.7
United Kingdom	NA	NA	NA	NA	2.0	NA	NA	NA	NA	3.5

SOURCES: Sumiye Okubo, Rolf Piekarz, Eleanor Thomas, "International Comparison of Enterprise-Funded R&D in Manufacturing" (paper presented at the Engineering Foundation Conference, Easton, Maryland, 1977); reproduced in National Science Foundation, Science and Technology: Annual Report to the Congress (August 1978), p. 77.

TABLE 26. DISTRIBUTION OF GOVERNMENT RESEARCH AND DEVELOPMENT EXPENDITURES AMONG SELECTED OBJECTIVES IN LEADING INDUSTRIAL COUNTRIES (In percent)

	United States a/	France b/	Germany b/	Japan c/	United Kingdom d/
National Defense	51	30	12	2	46
Space	13	5	5	5	2
Energy	9	9	11	8	7
Economic Development	9	23	13	23	20
Health	10	4	3	3	3
Community Service	5	2	5	3	2
Advancement of Knowledge	4	26	51	55	20

SOURCE: National Science Foundation, Science Indicators 1978, pp. 146-47.

a/ 1976-1977.
b/ 1976.
c/ 1974-1975.
d/ 1975-1976.

level as in 1961 (Table 27). By contrast, the number of U.S. patents granted to foreigners grew rapidly from the 1960s to the early 1970s.

TABLE 27. U.S. PATENTS GRANTED, BY TYPE OF OWNER, SELECTED YEARS, 1961 TO 1977

	All Patents	U.S. Government	U.S. Corporations	U.S. Individuals	Foreign
1961	40,154	1,460	27,382	11,233	79
1965	50,332	1,522	35,698	13,032	80
1973	51,509	2,078	36,515	12,677	239
1977	41,452	1,479	29,522	10,247	204

SOURCE: National Science Foundation, Science Indicators 1978, p. 219.

Diffusion of Efficient Technologies

New technologies become significant in economic development only to the extent that they are adopted throughout an industry or economic sector. It is difficult to determine whether the diffusion of new technologies slowed during the 1970s. Studies of particular kinds of new technologies suggest that diffusion became more rapid in the period after World War II. 11/ But there are no detailed studies of the most recent decade.

Certain indirect indicators suggest that diffusion may have slowed down. First, there has been a slowing in investment in new plant and equipment--a critical factor in the diffusion of some kinds of technologies. Second, economic uncertainty has probably been intensified by escalating prices of raw materials--particularly oil--and inflation in general. Third, some types of government regulations may have acted as deterrents by adding to

11/ Edwin Mansfield, Industrial Research and Technological Innovation (Norton, 1968), chap. 7 and 8.

uncertainty or by applying more stringent standards to new facilities than to old.

THE DETERMINANTS OF INNOVATION

Even though the process of innovation takes place throughout the economy, research and development appears to be quite highly concentrated. In 1974, about 85 percent of all industrial research and development was accounted for by six industries: communication equipment and components, machinery, aircraft and parts, guided missiles and spacecraft, motor vehicles and other transportation equipment, and chemicals. About 90 percent of all research and development in the private sector was done by only 200 firms. 12/

The Role of Small Business Firms

Some analysts believe that small businesses play an especially critical role in innovation, even though they spend relatively little on research and development. One study estimates that small businesses and independent operators played a significant role in as many as half of all important innovations during a recent period. 13/ The role of small businesses was found to be particularly important in the early stages of an innovation, although at the stage of commercial development larger firms tended to assume more of the burden.

Several characteristics of small businesses may tend to favor certain types of innovation. For one thing, the great number of

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12/ National Science Foundation, Science Indicators 1976; and National Patterns of Research and Development Resources 1978.

13/ National Science Foundation, Science Indicators 1976, chap. 4. There is substantial disagreement about the relative importance of small businesses in the innovative process. Some investigators have held that modern innovation requires so many resources that only very large firms can undertake them. Others disagree. Quantitative studies tend to suggest that smaller firms play an important, though by no means a dominant, role. See Mansfield, Industrial Research and Technological Innovation, chap. 5.

small businesses increases the opportunities for innovation. For another, small firms tend to be less rigid and possibly more receptive to new ideas than large corporations. Finally, large firms are more likely to be producers of a product or users of a process that would be adversely affected by the innovation.

Factors That Influence Business Decisions

Economists believe that the factors influencing the decisions of businesses to spend on R&D and to innovate are similar to those influencing their decisions regarding investment in general. The prospect of earning a profit from the R&D expenditure is crucial. But the profit outlook for R&D investments depends on many things, including sales, the cost of funds, and government regulations.

Economic Conditions. The general state of the economy is believed to be a major determinant of innovation. If the economic environment is favorable to investment and risk-taking, it is conducive to innovation.

A number of studies suggest that the economic returns from investments in R&D were relatively high in the 1960s, and the rapid growth in private-sector R&D is consistent with those observations. 14/ But why did the growth slacken considerably during the 1970s? A good deal of circumstantial evidence suggests that the climate for innovation, and the prospective returns for R&D in particular, may have deteriorated during the 1970s. First, higher inflation may have added to uncertainty and caused businesses to curtail their R&D plans, especially for basic research which has a more delayed and uncertain payoff than many alternative investments. Second, in a number of areas, increased government regulation added substantially to the costs and uncertainty of innovation. Third, the 1970s were characterized by considerable economic slack.

The existence of economic slack and the outlook for sluggish growth in sales tended to discourage innovation in much the same way as they discouraged business fixed investment. They also discouraged the diffusion of innovation to the extent that this

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14/ See footnotes 5 and 6 of this chapter.

depends on the installation of new plant and equipment. Industry-financed R&D spending continued at about 1.0 percent of GNP, as it had since the early 1960s, but as the growth in real GNP slowed so did innovations.

Another negative influence--related to those already mentioned--was the depressed state of the capital markets during much of the 1970s. This was especially discouraging to the development of small, high-technology businesses. As shown in Table 28, the value of stock issued by companies with net worth of less than $5 million fell dramatically during the recession of 1973-1975, and the recovery has been slow and incomplete. This part of the capital market tends to mirror developments in equity markets as a whole, but it is more volatile. The pessimism of the capital markets was unusually deep and prolonged during much of the 1970s.

TABLE 28. STOCK ISSUED BY COMPANIES WITH NET WORTH OF LESS THAN $5 MILLION, 1969-1980

Period	Number of Issues	Share Value (millions of dollars)
1969	698	1367
1970	198	375
1971	248	551
1972	409	896
1973	69	160
1974	9	16
1975	4	16
1976	29	145
1977	13	43
1978	21	129
1979	46	183
1979 1st half	16	56
1980 1st half	30	149

SOURCES: Venture Capital, Inc., cited in The Washington Post (November 18, 1979), p. G-1; 1979 and 1980 first half from Capital Publishing Corporation.

Management Attitudes. Innovation may also have been dampened by changes in the way managers work. Some analysts feel that U.S. managers today focus more on short-term earnings performance than they did in the past, or than their counterparts do in other industrialized countries. Some observers also believe that modern managers have less technical knowledge of, or commitment to, their industry. 15/

POLICIES TO STIMULATE INNOVATION

The preceding survey of factors affecting innovation suggests that policies to stimulate it might focus on three aspects of innovation: research and development, diffusion of technologies, and small high-technology business firms. The deterioration of the economic climate has probably been a contributing factor behind the slowdown in R&D spending--particularly that for basic R&D--and behind the near-collapse in the public capital market for new high-technology firms. The best tonic for these ills probably would be an end to inflation and recession. But short of that, the following policy options might tend to offset some of the negative factors.

Policies to Stimulate R&D

The social returns from R&D seem to have exceeded considerably the private returns, and may also have been high compared with the social returns from alternative investments. Social benefits seem likely to exceed private benefits to a greater extent in basic research than in development and commercial application, because the results of basic research have broader applicability and may not be patentable. The case for public support of research and development may also be stronger in industries characterized by

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15/ See, for example, the statement of Robert B. Reich, Director, Office of Policy Planning, Federal Trade Commission, Hearings on Economic Growth, Senate Select Committee on Small Business, 96:2 (June 24, 1980); and R.H. Hayes and W.J. Abernathy, "Managing Our Way to Economic Decline," Harvard Business Review (July-August 1980), pp. 67-77. If true, some of the basic reasons may include the structure of capital markets in the United States that reward stable earnings growth and increased government regulation of the private sector.

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many small producers than in industries with a few large firms. Single producers in small-producer industries (for example, agriculture) are often not large enough to justify research. 16/

Accelerated Depreciation. Capital used in R&D might be made subject to accelerated depreciation for tax purposes. Accelerated depreciation is used in several countries as a way of stimulating R&D. Canada and Great Britain permit full depreciation in the first year of some types of capital, including that used for R&D. A number of other countries, including France and Germany, allow more rapid depreciation for R&D-related capital than for other types of capital. In the United States, rapid depreciation is permitted for some types of investments in which social benefits may exceed private returns, as in pollution abatement and low-income housing.

Tax Credits. Another frequently mentioned incentive would be a tax credit for R&D expenses. Under current laws, R&D operating costs can be expensed, rather than treated as an investment to be amortized over a period of years. A tax credit for R&D expenses would be similar to the tax credit for equipment.

Critics of the tax-incentive approach raise two basic objections. For one thing, they believe that tax measures might not stimulate much additional R&D spending. If it did not, the revenue loss might be large in relation to the net addition to R&D spending. They also argue that a tax credit for R&D expenses would be difficult to administer, since it would be hard to distinguish R&D expenses from ordinary business expenses. (The same persons may be involved in research and in more routine production; or an expensive computer may be used both for research and for ordinary accounting.)

16/ Other recent discussions of policy options to stimulate innovation include: Joseph J. Cordes, The Impact of Tax and Financial Regulatory Policies on Industrial Innovation (National Academy of Sciences, 1980); Eileen L. Collins, "Sorting Out the Arguments Underlying Proposed Tax Incentives to Encourage Innovation" (paper prepared for the annual meeting of the American Economic Association, September 5-7, 1980); Committee for Economic Development, Stimulating Technological Progress; and National Academy of Engineering, Industrial Innovation and Public Policy Options: Report of a Colloquium (National Academy Press, 1980).

Critics of R&D tax credits also raise several other points: The option to expense a large part of an R&D investment already constitutes a significant tax advantage. 17/ In addition, the benefits of a tax credit for research and development would be very unequally distributed, since a relatively few large firms account for a large proportion of total research and development in the private sector. Many firms--particularly young, small firms--might not have enough taxable income to use the tax credit.

Modifications could be made in response to these criticisms, such as limiting an R&D tax credit to increases in R&D spending from some base level. 18/ But this would make the credit more cumbersome and difficult to administer. Or the credit might be limited to firms below a certain size, or to particular industries. Alternatively, it could be targeted on research and development in capital goods industries, where innovations help to increase productivity in other industries. The tax credit could also be made refundable--which would help small businesses. 19/

17/ Economists believe that the option to deduct a capital investment in one year for tax purposes--to expense the investment--tends to be roughly equivalent to a zero tax on the return from that capital.

18/ H.R. 5829, as reported by the Senate Finance Committee, would provide for an income tax credit of 25 percent of the increase in qualifying research and experimental expenditures from the base period. See Tax Reduction Act of 1980, Report of the Senate Committee on Finance, 96:2 (1980), pp. 92-100.

19/ Another tax issue in the area of R&D is presented by Treasury Regulation 1.861-8, which prescribes the allocation of overhead expenses of multinational companies. An international company is required to apportion its overhead costs, including those for research and development, between domestic and foreign sources, even if they are not directly traceable to its foreign operations. Previously, a research and development expense was deductible for U.S. tax purposes unless it was directly related to foreign operations. The impact of this change on R&D activities is unclear. Some spokesmen for multinational firms hold that this will discourage a significant amount of research, but some other observers believe that this kind of R&D is not sensitive to tax policies.

The impact of special tax incentives is difficult to evaluate, for lack of U.S. experience with them. Some countries--including Canada--have tax credits for increases in R&D spending, as well as accelerated depreciation for capital used in R&D, but the quantitative impact of such tax measures on R&D spending is unknown. 20/ The problem of defining R&D spending would probably be easier in the case of accelerated depreciation than it would for a tax credit on current expenditures for R&D.

Options on the Outlay Side of the Federal Budget. One possibility would be to reorder existing priorities for federally sponsored R&D so as to place a relatively greater emphasis on projects related to productivity. Another would be to extend the use of government contracts and grants for specific kinds of R&D. Loans or loan guarantees might be used for particular projects. Price guarantees might provide incentives for the private sector in cases where large long-term investments are needed for projects in the national interest. 21/

The Carter Administration proposed the establishment of "generic technology centers" that would develop technologies in particular industrial sectors and make them generally available. The proposal called for the establishment of four such centers in 1981, to be sponsored by the National Science Foundation and the Department of Commerce at a cost of $6-8 million.

The Carter Administration also proposed an increase in the Small Business Innovation Program administered by the National Science Foundation, which provides funding to small companies for

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20/ For discussions of foreign measures to stimulate R&D, see Organization for Economic Cooperation and Development Policies for the Stimulation of Industrial Innovation (OECD, 1978), Robert S. Kaplan and others, "Tax Policies for R&D and Technological Innovation" (Graduate School of Industrial Administration, Carnegie-Mellon University, 1976; processed), chap. 1; and Gilles Paquet, "Taxation and Science Policy," Canadian Tax Journal, vol. 19, no. 5 (1971), pp. 429-37.

21/ For a more detailed discussion, see National Science Foundation, Division of Policy Research and Analysis, "Direct Federal R&D Support and Industrial Innovation: A Review of Recent Literature" (prepared for President's Domestic Policy Review on Industrial Innovation, December 1978; processed).

projects involving new technology. The proposal would increase the funding level for this program from about $2.5 million to $10 million in fiscal year 1981. 22/

A "development bank" could combine elements of the public- and private-sector approaches. Such a bank could employ a variety of instruments, including loans, loan guarantees, or price guarantees, and it could use them to target resources on the development of specific technologies. This is the general approach now being used to encourage the development of the synfuels industry.

Proponents of tax measures to stimulate R&D argue that this approach would be easier to administer, and would involve less interference with markets, than an approach involving government contracts and grants. They argue, too, that the government is not "good at picking winners" and therefore should avoid choosing among R&D projects that have potential commercial application. On the other hand, proponents of the government expenditure approach argue that tax measures are inefficient because they tend to subsidize businesses for doing what they would do anyway.

To a large extent, the choice of an appropriate instrument for stimulating R&D would depend on the particular purpose. If the purpose was to provide a general stimulus, a tax-incentive approach might be more advantageous. On the other hand, the government-spending approach would lend itself better to targeting on specific kinds of projects. 23/ Tax measures can be targeted to

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22/ The President's Message on Industrial Innovation of October 31, 1979, contained proposals in nine areas: enhancing the transfer of technical information, increasing technical information, improving the patent system, clarifying antitrust policy, fostering the development of smaller innovative firms, improving federal procurement, improving the regulatory system, facilitating labor/management adjustment to innovation, and maintaining a supportive attitude toward innovations.

23/ One reason that a tax approach tends to be easier to administer than a grant or contract approach is that the tax approach establishes a broad category of eligibility. If a grant program involved an entitlement, however, it might be about as easy to administer as a tax incentive with similar eligibility criteria. Both would tend to have similar "budget costs."

some extent, but they may serve better to provide a general stimulus.

Government regulations--including antitrust policy--may in certain cases bear heavily on the amount and effectiveness of private-sector R&D. In the drug industry, for example, the increased testing required in developing a new product might justify extending the period of protection under patent laws beyond the current 17 years. Uncertainty as to future changes in government regulations may itself be a drag on R&D, and reducing this uncertainty might help to stimulate some kinds of R&D.

Policies to Stimulate Diffusion of New Technologies

Investment. A basic approach to stimulating the diffusion of technology would be to increase the rate of business investment in plant and equipment. New technologies tend to be "embodied" in new capital. Measures to stimulate business investment are discussed in Chapter III.

Information. The flow of information also plays an important role in the diffusion process. In the postwar period, several countries--Japan and Germany in particular--have been very skillful in copying and adapting new U.S. technology. More recently, some countries have caught up and moved ahead of the United States in certain kinds of technology. This country might now benefit from an increased attention to technologies developed in other countries.

Patent Rights. A more specific approach would be to liberalize patenting rights for new technologies developed under government contracts. Currently, these generally belong to the government, and there is not much incentive for contracting firms to develop the resulting new technologies. One proposal would allow small businesses and universities substantial patent rights on projects developed under government contracts. 24/

24/ S. 414, the University and Small Business Patent Procedures Act.

Policies to Stimulate Small, High-Technology Businesses

Small business firms may suffer more than larger firms from the negative effects of government regulation. Similarly, the depressed state of capital markets during much of the 1970s could be expected to have a more pronounced effect on small and new firms than on large, established firms.

A number of proposals have been made to encourage small, high-technology businesses. 25/ One proposal would be to extend the period over which losses can be carried in determining income tax liability from five years under current law to a longer period such as ten years. This would particularly benefit small innovative businesses if they incurred heavy and prolonged expenses in developing new or improved products.

Small, high-technology businesses have particular difficulty in obtaining access to capital markets and in coping with government regulations. Many of the other proposals for stimulating small business relate to these problems. One approach would give further tax incentives to investors in small, high-technology enterprises. 26/ For example, the capital gains tax might be differentially lowered on this kind of investment. A related proposal would permit investors to roll over funds without capital gains tax if the proceeds were reinvested in the same type of investment. Another would give a tax credit to persons investing in small, high-technology businesses. Still another proposal would raise the limit on the size of net capital losses that can be deducted in any one year from ordinary income (currently $3,000). Economists do not know much about the quantitative effects of such tax measures on small, technology-based firms or on innovation.

25/ See SBA Advisory Task Force, Small Business and Innovation, Report to the Office of the Chief Counsel for Advocacy, U.S. Small Business Administration (May 1979).

26/ Currently, some provisions of the tax code provide special incentives for investors in small businesses. These include lower corporate income tax rates in the first $100,000 of income and special tax treatment of venture capital companies, Subchapter S corporations, and loss on small business capital stock. See Collins, "Sorting Out the Economic Arguments Underlying Proposed Tax Incentives to Encourage Innovation."

One drawback is that they would create new tax shelters and thereby reduce the horizontal equity of the tax system.

It has been suggested that federal financial regulations are a major impediment to small businesses in gaining access to capital markets. Under Regulation A of the Securities and Exchange Commission, new issues of stock involving less than $1.5 million can avoid full SEC requirements for information. Some have proposed that the limit should be raised. A cost of doing so would be the reduction in information available to prospective investors. 27/

Easier credit terms might offer another way of increasing access to financing for small, high-technology firms. For example, the Small Business Administration (SBA) could be encouraged to make loans to this kind of venture. At present, only a small number of SBA loans are of this kind. 28/ Many such ventures are too speculative to meet current SBA guidelines. Alternatively, another financial institution could be established to encourage lending to this segment of small business.

Government purchasing could also place more emphasis on small business. Currently, small business firms obtain a relatively small share of government contracts and of government R&D, despite official policies intended to increase it. One option would be to require agencies to allocate specific percentages of their contracts to small businesses. 29/ But this approach could result in less efficient purchasing.

27/ SEC Rules 144 and 146, which govern "private" or "non-public" offerings of securities are also relevant. For an explanation of Rules 144 and 146 and Regulation A and a discussion of their economic impact, see James R. Barth and Joseph J. Cordes, Evaluating the Impact of Securities Regulation on Venture Capital Markets, U.S. Department of Commerce, National Bureau of Standards, Monograph 166 (June 1980).

28/ The Small Business Investment Act, as amended, authorizes the SBA to purchase or to guarantee debt issued by small business investment companies. The program level is estimated at roughly $200 million for fiscal year 1981.

29/ See S. 2749, the Small Business Innovation Act of 1980.

CONCLUSIONS

Policies to reverse the slowdown in innovation that seems to have occurred during the 1970s might employ a variety of instruments: tax, budgetary, regulatory, and patent measures. Policies should aim at the diffusion as well as the development of new technologies, because a new discovery does not help productivity unless it is commercially implemented. Different tools may be needed for different objectives. Tax incentives might be considered as a general measure to stimulate R&D, but a more direct government involvement might be needed to stimulate R&D in some situations--for example, in industries made up of small producers. Basic research may require special public support because its potential benefits frequently cannot be adequately captured by those undertaking the research. There is generally a lack of information about the likely quantitative effects of various proposals for stimulating innovation.

CHAPTER VI. GOVERNMENT REGULATION AND PRODUCTIVITY

Government regulation of the economy has become an important influence on productivity growth. During the last 15 years, the scope of regulation has grown to include protection of the environment, occupational health and safety standards, product safety, equal employment opportunity, pension standards, and energy, to mention only some of the most important areas. This chapter discusses the ways in which government regulations affect productivity growth, and some approaches to regulation that might lessen its impact.

The implications are complex. Some kinds of regulation are clearly desirable and produce benefits to society. These benefits are not measured in statistics of productivity, although the hours of labor used in producing them are, and consequently they have a negative effect on indexes of output per hour worked.

Some forms of government regulation also tend to retard innovation and investment, which are essential to the growth of productivity. The current reliance on "command and control" regulation is costly in its effects on productivity growth. Proposals for improving the regulatory process include the use of incentives that would enlist market forces in the attainment of public objectives--for example, an effluent tax on activities polluting the environment.

IMPACT OF GOVERNMENT REGULATIONS ON PRODUCTIVITY GROWTH

Two kinds of government regulations are particularly important from the standpoint of productivity: economic regulations and social regulations. Economic regulations are those applied to certain industries in which monopoly elements are judged to be prominent, such as utilities and railroads. This type of regulation--covering matters such as price-setting and entry into an industry--has been in existence for quite a long time, in most cases decades. More recently, regulations have been used increasingly to meet social objectives.

TABLE 29. GOVERNMENT SOCIAL REGULATION--A PARTIAL LIST OF MAJOR LEGISLATION

Category/Legislation	Date
Protection of Environment	
Air Quality Act	1967
Clean Air Amendments	1970
Clean Air Act Amendments	1977
Water Quality Act	1965
Water Pollution Control Act Amendments	1972
Clean Water Act	1977
Safe Drinking Water Act	1974
Motor Vehicle Air Pollution Control Act	1965
National Environmental Policy Act (NEPA)	1970
Endangered Species Act	1973
Federal Environmental Pesticide Control Act	1972
Toxic Substance Control Act	1976
Resource Conservation and Recovery Act	1976
Surface Mining Control and Reclamation Act	1977
Noise Control Act	1972
Quiet Communities Act	1978
Occupational Health and Safety	
Occupational Safety and Health Act	1970
Federal Metal and Nonmetal Mine Safety Act	1966
Federal Coal Mine Health and Safety Act	1969
Mine Safety and Health Act	1977

(Continued)

Growth of Social Regulations

The growth in social regulation of the private economy bears heavily on productivity. Some of the most important pieces of federal legislation in the area of social regulation are listed in Table 29.

An important feature of these major pieces of federal legislation is that they involve a high degree of centralization in

TABLE 29. (Continued)

Category/Legislation	Date
Consumer Protection	
Consumer Product Safety Act	1972
Food, Drug and Cosmetic Act	1938
Food, Drug and Cosmetic Act Amendments	1962
Civil Rights and Equal Pay	
The Civil Rights Act (Title VII deals with equal employment opportunity and became effective on July 2, 1965)	1964
Equal Pay Law (Equal pay for women)	1963
Age Discrimination in Employment Act	1967
Fair Housing Act, Title 8	1968
Equal Credit Opportunity Act	1974
Financial Protection	
Employment Retirement Income Security Act (ERISA)	1974
Consumer Credit Protection Act	1972
Home Mortgage Disclosure Act	1975

administration and concern with detail. For example, as a result of the 1970 Clean Air Amendments, the Environmental Protection Agency (EPA) established permissible standards for certain kinds of air pollutants. In addition, the Federal Water Pollution Control Act of 1972 required EPA to develop specific water quality standards for each type of industrial process and to issue permits for every industrial source. By 1977, the effluent limits were to be consistent with the "best practicable control technology currently available," and by 1983, with the "best available technology

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economically available." Among other factors, EPA was to consider economic feasibility in setting effluent standards. (The Clean Water Act of 1977 introduced some modifications--particularly, some of the compliance deadlines were postponed--but the basic approach remained unchanged.)

Implications for Productivity

Both the economic regulations and the more recent social regulations tend to retard productivity growth in the private sector, but the latter have probably had a much stronger impact since the mid-1960s. Most of the economic regulations, such as those for railroads, have been in effect for many years. The social regulations may also impose more severe costs on the economy than the older, industry-related regulations. For one thing, the new kind have broad objectives that cut across industry boundaries. They also tend to be focused on a single goal, such as raising environmental standards or improving occupational safety and health. As a result, the administering agency may have difficulty in taking a balanced view of the industry, including broader economic considerations. By contrast, the "older" form of regulation was likely to have an industry orientation, requiring the regulating agency to consider the welfare of the particular industry. 1/

Government regulations have two kinds of costs that relate to productivity growth. One is the cost of the resources used in implementing the government regulation. Resources devoted to meeting government regulations are not available for producing ordinary goods and services.

Another kind of cost involved in government regulation is that it may slow innovation and diminish business incentive to invest in new projects. Some analysts believe that such dynamic costs are substantial, including longer delays and additional uncertainty. For example, current regulatory procedures that impose more stringent requirements on new, as compared with existing, facilities create incentives to delay new investment and new innovations. The drug industry has argued that regulations have

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1/ See, for example, Murray T. Weidenbaum, The Costs of Government Regulation of Business, Subcommittee on Economic Growth of the Joint Economic Committee, 95:2 (1978).

become so strict that the introduction of new products takes much longer and costs much more than formerly. Finally, government regulations may divert managerial attention from activities that contribute to productivity improvement. 2/

All of the costs, but only a part of the benefits, of government regulation get reflected in the conventional measure of labor productivity. 3/ The Commerce Department estimates that the private business cost of implementing the pollution abatement regulations was approximately $22 billion in 1977. Spending for pollution abatement capital accounted for roughly 5 percent of total capital outlays in 1977, but the percentage varied considerably in different industries and sectors of the economy (see Table 30). Growth in the capital stock is notably reduced by adjusting for pollution abatement, particularly in manufacturing (see Table 31).

The increase in government regulation is believed to present a special burden for small businesses, and this could adversely affect innovation. 4/ Compliance with regulations may require quite specialized and highly skilled manpower. Small firms also may lack the financial resources needed to comply with regulations and, in some cases, this may prevent new firms from entering an industry.

2/ For discussion of the impact of regulation on innovation, see George C. Eads, "Regulation and Technological Change: Some Largely Unexplored Influences," American Economic Review, Papers and Proceedings (May 1980), pp. 50-54; Henry G. Grabowski and John M. Vernon, The Impact of Regulation on Industrial Innovation (National Academy of Science, 1979); and U.S. Department of Commerce, Advisory Committee on Industrial Innovation: Final Report (September 1979), pp. 37-114.

3/ To the extent that the regulation results in an "improved product" purchased by consumers it also gets reflected as an increase in output, but the increased costs of business in cutting down on pollution associated with production do not get reflected at all in output measures.

4/ The role of small business in innovation, and policies to stimulate this source of innovation, are discussed in Chapter V of this report.

TABLE 30. EXPENDITURES FOR POLLUTION ABATEMENT CAPITAL BY INDUSTRY, 1977 (In percent of total capital outlays)

Industry	1977
All Industries	5.1
Manufacturing	7.0
Durable goods	5.9
Primary metals	15.7
Electrical machinery	3.4
Machinery, except electrical	1.8
Transportation equipment	3.1
Stone, clay, and glass	7.3
Other durables	3.6
Nondurable goods	8.0
Food, including beverage	4.2
Textiles	3.8
Paper	13.8
Chemicals	10.2
Petroleum	8.2
Rubber	3.3
Other nondurables	1.2
Nonmanufacturing	3.5
Mining	2.2
Railroad	1.0
Air transportation	0.8
Other transportation	1.0
Public utilities	8.8
Communication, commercial, and other a/	0.5

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, as presented in Economic Report of the President 1979, p. 127.

a/ "Other" consists of trade, service, construction, finance, and insurance.

TABLE 31. RATES OF GROWTH OF THE CAPITAL STOCK, INCLUDING AND EXCLUDING POLLUTION ABATEMENT CAPITAL, BY SECTOR, SELECTED PERIODS, 1948-1978 (Annual averages, in percent)

	1948-1965		1965-1973		1973-1978	
Sector	Total	Excluding pollution abatement capital	Total	Excluding pollution abatement capital	Total	Excluding pollution abatement capital
Private Business	3.14	3.11	4.48	4.37	2.31	2.05
Private Nonfarm Business	3.24	3.21	4.59	4.47	2.37	2.09
Manufacturing	2.93	2.86	3.93	3.64	2.16	1.47

SOURCE: J.R. Norsworthy and others, "The Slowdown in Productivity Growth: Analysis of Some Contributing Factors," Brookings Papers on Economic Activity (1979:2), p. 405.

Some partial estimates of the impact of government regulation on productivity growth are available. According to one study, two of the major kinds of government regulation--pollution abatement and occupational health and safety--reduced productivity growth by 0.24 percentage points a year from 1973 to 1976. 5/ Another

5/ Edward F. Denison, Accounting for Slower Economic Growth (Brookings Institution, 1979), p. 114; for a more detailed analysis, see Edward F. Denison, "Effects of Selected Changes in the Institutional and Human Environment upon Ouput per Unit of Input," Survey of Current Business (January 1978), pp. 21-44.